Drosera indica from Narrabri, New South Wales

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Introduction

Over the last two years I have been studying a population of *Drosera indica* near the town of Narrabri, approximately 250 km north of Dubbo. Plants in this population have a few interesting features including a strong fruity smell to the mucilage on the leaves and the development of functionally unisexual flowers.

Drosera indica is a widespread annual sundew found in tropical and subtropical environments on lands bordering the Indian Ocean and extending into southeast Asia (Diels, 1906). The linear leaves are typically 50 to 100 mm long, lack stipules, and are born along an erect to trailing stem up to 200 mm long. The white, pink or rarely orange-petalled flowers are borne on a one-sided raceme, and produce an abundance of ovoid seed with a scrobiculate (minutely pitted) surface. There are a number of forms and variants within the species, including plants with hooded, red stamens and seeds with an anatomizing sulcate surface; a diminutive form with leaves only 20 mm long; and a form with relatively broad leaves with stalked marginal glands along the entire margin (Lowrie, 1998). From herbarium study, two centers of diversity within the species can be inferred, i.e. northern Australia and Indochina. Many of these forms have been recognised by earlier authors and often described as separate species or varieties (e.g. Planchon, 1848; Mueller, 1855 and Bentham, 1864). Perhaps *Drosera indica* is best viewed as a species complex until an overdue taxonomic revision is conducted?

The Narrabri Plants

The *Drosera indica* site near Narrabri, 30°12'S, 149°29'E, occurs in the sandy creek bed of an ephemeral stream. The sundew grows in shallow depressions, often between 60 and 100 cm above the surface of temporary pools, under a canopy of the reed *Phragmites australis*. Plants were seen actively growing and flowering in March 1999, June 1999, and July 2000.

Drosera indica at this site is remarkably uniform in appearance and has an overall yellow-green colour. The erect to scrambling stems grow to 150 mm tall and are typically 2 mm diameter. They have a remarkably well-developed root system. The linear leaves reach 100 mm long by 3.5 mm wide and have weakly recurved margins, with long-stalked retentive glands along the full leaf margin (see Figures 1, 2). Internode length increases up the stem. The lowermost leaves appear to be borne in whorls of three then become distinctly alternate. Upon reaching maturity, racemes are produced opposite every third to fifth leaf. These are up to 150 mm long, weakly ascending to horizontal, carry between three and twelve flowers, and extend beyond the leaves. Narrowly triangular bracts are produced near the base of every second to third flower. Each bloom is held on a terete pedicel typically 6 mm long, however the basal first or second flower(s) may have pedicels 15 mm long. Each flower has five sepals and five white petals. The sepals are lanceolate; typically 4 mm long by 1.5 mm wide, and have a weakly glandular hairy-dentate apex.

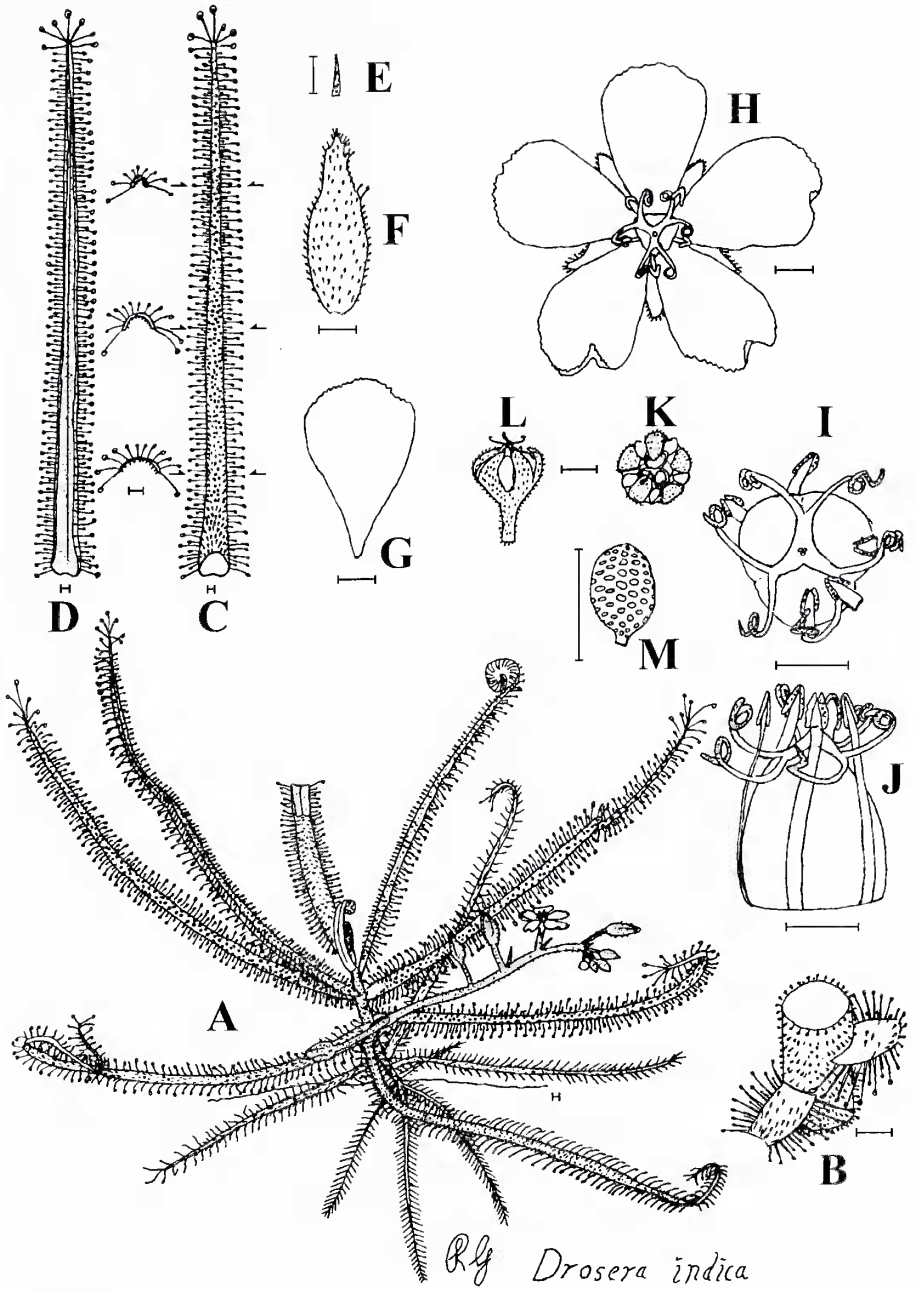

Figure 1: *Drosera indica* from Narrabri drawn from live, cultivated specimens. A: Entire plant; B: close up of a section of stem showing retentive gland arrangement at the base of two leaves; C: leaf upper surface; D: leaf lower surface; E: bract; F: full- sized sepal; G: full-sized petal; H: open flower from above; I: ovary, styles and stamens from above; J: ovary, styles and stamens viewed from the side; K: functionally female flower from above; L: functionally female flower from the side; M: mature seed. Note the three cross sections of the leaf in C and D. Scale bar = 1 mm.

Figure 2: Typical *Drosera indica* from Narrabri.

Figure 3: *Drosera indica* from Narrabri with functionally female flowers.

Figure 4: Functionally female flowers on *Drosera indica*.

The fully formed petals are obovate, 5 mm long and 3 mm wide. The ovary is olive green, glabrous, ovoid to conical, 2 mm tall by 1.4 mm diameter and surmounted by 3 styles, which are bifid from the base. Each style segment is approximately 2-4 mm long, with the apex often strongly reflexed. The five stamens are borne on white, flattened filaments up to 2.5 mm long. Flowers have the ability to self-pollinate. Each produces approximately 200 ovoid seeds. The terete stem, leaf under-surface, peduncle, pedicels, sepals and bract upper surface are covered in short-stalked retentive glands. This variant strongly resembles *D. indica* var. *robusta* of Bailey (1913).

A study of herbarium specimens at the New South Wales and Queensland State Herbaria has shown that *D. indica* plants with leaves of comparable width and distribution of long stalked peripheral retentive glands have been collected at several locations across Australia, particularly in ephemeral wetlands in arid regions. In addition I have observed similar plants, with pink-petalled flowers, beside an ephemeral creek near the town of Leinster, 27°51'S, 120°41'E, in the Western Australian desert. Germination had been triggered by local flooding. Lowrie (1998) has an illustration of a very similar plant that was growing in the town of Cue, which is only approximately 250 km from Leinster (see his Figure D on page 183). The plants at both Leinster and Narrabri had the characteristic sweet, fruity smell emanating from sticky secretions from the retentive glands; this feature may promote the attraction of flower-visiting, flying insects. This character has been noted by Australian aborigines who have used this sundew as a bush food by either sucking the sweet, sticky fluid directly from the leaves or soaking the entire plant in water, and then consuming the sweet drink (Latz, 1995: page 162).

Both filament and petal lengths may vary within and between plants in the population at Narrabri. Typically the flowers have petals which are longer than the sepals and filaments that are as long as the ovary so that, as the flower closes, pollen may be easily transferred from the anthers to the stigmatic surface thus facilitating autonomous self-pollination. During my visit to the site in July 2000 plants with consistently unusual flowers were seen amongst those with typical blooms. These unusual plants had poorly developed greenish petals, only 2 mm long by 1 mm wide, which were held against the ovary by strongly incurved sepals (see Figures 3, 4). The stamens were on filaments up to 1 mm tall and were concealed by the sepals. These flowers were not seen to open further, in the wild or in cultivation, and appeared to be functionally female. Seedlings with both types of flower were brought into cultivation and grown for five months. In some plants the petal length and filament length remained short in all subsequent flowers produced. These flowers were unable to self pollinate autonomously, and set no seed in cultivation. However, the flowers produced on other plants had petals and filaments that increased consecutively in length per raceme, until reaching a maximum, stable size. When collected in July, this variant had petals which scarcely exceeded the sepals and anthers held below the styles and was bearing fruit. When collected in July, this variant had petals which scarcely exceeded the sepals, the anthers were not long enough to reach the styles. Meanwhile, some of the older flowers were already ripening into fruit. Then, seed production halted until spring when the filaments on extant flowers had longer filaments. Due to the brief period of time that the flowers were open none were artificially pollinated. Thus the viability of pollen and receptiveness of styles on the succession of flowers could not be tested.

Another unusual feature seen in cultivated plants was the development of growing points from the base of bracts on the raceme. Each of these formed a small rosette with leaves up to 5 mm long, without discernable internodes. None formed independent plants and all died with the raceme.

Discussion

Variation in filament and petal length is likely to influence the attractiveness of flowers to possible pollinators, male function (i.e. pollen donation) and the breeding system of the plants in this population (e.g. Vaughton & Ramsey, 1998). Flowers with larger petals are likely to be more visible, and thus attractive to potential pollinating insects. Larger flowers are likely to have readily accessible anthers and subsequently have the potential both to set seed from imported pollen and also donate it for potential subsequent cross-pollination events. They also retain the ability for autonomous self pollination. In contrast, the flowers with very short petals and filaments are probably less attractive to potential pollinators, have concealed anthers and thus likely reduced male function and lack the ability of autonomous self pollination. However, they have prominently exposed styles, and thus favour the interception of pollen from other plants, i.e. promoting out-crossing.

This species is an opportunistic annual, which has the ability to set a prodigious amount of seed (e.g. if one plant produced five racemes in a season with an average of 8 flowers each, and all of these set seed, then this plant could potentially produce $5 \times 8 \times 200 = 8000$ seeds), which are typically long-lived. The changing floral morphology and thus breeding system of some plants in this population during the flowering season may have a genetic advantage. The almost universal occurrence of out-crossing individuals early in the season guarantees the production of high quality, and possibly low quantity seed. Perhaps to counter the risk of possible local extinction, the species develops the potential to produce a larger quantity of low quality self-pollinated seed towards the end of the growing season: from the plant's perspective it is better to delay genetic quality control in order to guarantee long-term survival. This mixture of separate functionally female and hermaphroditic flowers within a population is termed gynodioecy, which has hitherto been unreported for *Drosera*.

Further field studies and cultivation trials appear warranted to fully document the change in filament and petal length over the growing season, and noting the fertility of each form. It would be interesting to know if this feature occurs within other populations of this form, or indeed any other *Drosera*.

In conclusion the study of *Drosera indica* plants from the nearby site at Narrabri, in the wild and in cultivation, has led to some puzzling observations on changing petal and filament length in the flowers of successive scapes during a growing season and between plants over time. These have raised questions on the breeding system of the population, and have led to speculation on why this phenomenon occurs.

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